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THE AMERICAN GAS LIGHT JOURNAL

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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

Sixteenth Annual Meeting, Western Gas Association.

SECRETARY'S OFFICE, WESTERN GAS ASSOCIATION,
QUINCY, ILLS., April 10, 1893.

The Sixteenth Annual Meeting of the Western Gas Association will be held at Chicago, on the 17th, 18th and 19th days of May.

The Victoria Hotel will be used as the Association's headquarters, while the business sessions will be conducted in Kinsley's Hall, No. 105 Adams street. It will be recalled by many of our members that our meeting of '88 was held at Kinsley's, and that a more admirable assembly room for our purposes could hardly have been chosen.

While, as above indicated, the Victoria Hotel has been designated as headquarters of the Association, yet the great majority of our members will be compelled to seek accommodations elsewhere, as it has been found impossible to secure any one hotel which is able to provide for all in consequence of the great rush of visitors to the Columbian Exposition, at that time expected. However, there need be no fear on the part of our members as regards securing comfortable quarters and at reasonable prices, provided that rooms are engaged in advance. Rooms should be written for by the 1st day of May at the latest, and the writers should request acknowledgments of their applications from the hotel proprietors, so that there may be no possibility of failure in securing accommodations.

The Local Committee of Arrangements for the Chicago meeting consists of the following named gentlemen: Carl D. Bradley (Chairman), Chas. D. Hauk, A. S. Miller, John Stout, C. F. Bryant, F. K. Waugh, P. S. Dickey, S. S. Stratton, F. R. Persons, H. M. Hubbard, H. D. Harper and Chas. V. Newman. From this general committee the following have been appointed as a special committee on hotel accommodations: S. S. Stratton, A. S. Miller and Chas. V. Newman. The members of said special committee have canvassed the situation thoroughly and report that the following hotels have agreed to provide for the number of guests set opposite their respective names, and at prices as here stated:

Victoria.....	50	guests, at	$2.00 to $5.00	per day.		
Great Northern...	50	"	"	2.00	per day and	upwards.
Gore's Hotel	50	"	"	1.50	"	"
McCoy's Hotel...150		"	"	1.50	"	"
Saratoga Hotel...150		"	"	1.00	"	"

The hotels above named will be conducted on the European plan exclusively.

The Grand Pacific, operated on the American plan, will provide for 50 of our members, upon receipt of three weeks' notice, at prices ranging from $4 per day, upwards.

The Leland, conducted both upon the American and European plans, will accommodate at their regular rates a limited number of guests upon receiving timely notice from the applicants.

The Rossmore, Wabash avenue, between 18th and 19th streets, a new and finely equipped hotel, especially adapted to family requirements, will take care of 100 guests at their regular rates of $3 to $5 per day. The Rossmore is under the management of the Victoria, which would seem to be a guarantee of excellence.

While the following hotels do not guarantee to reserve accommo-

dations for our members upon receipt of applications, yet a limited number can probably secure rooms if the same are booked at once: The Auditorium, Palmer House and Tremont.

When making applications for quarters, members should write directly to the hotel proprietors and not to the committee on hotel accommodations, although if there is any special information desired beyond that stated in this notice, the members of the committee in question will gladly supply the same.

Further information regarding the papers which will be presented and matters pertaining both to the business and social features of the forthcoming meeting, etc., will be published in subsequent issues of the JOURNAL.

As it is expected that an unusually large number of applications for membership will be made on the occasion of our Sixteenth Annual Meeting, it is advised that the same be filed at an early day with the undersigned. A. W. LITTLETON, Secretary.

QUINCY, ILLS., April 17, 1893.

The following papers will be presented at the Chicago meeting:

"Practical Gas Analysis, with Experimental Illustrations," by Mr. O. O. Thwing, St. Louis, Mo.

"On the Best Method of Construction of Oil or Naphtha Tanks for Storage Purposes," by Mr. F. D. Moses, Chicago, Ills.

"The Duties of Gas Companies to their Patrons," by Mr. H. D. Walbridge, Grand Rapids, Mich.

"The Relative Economies of Gas Engines and Electric Motors," by Mr. Jas. R. Smedberg, Chicago, Ills.

"Wrinkles," by Mr. Geo. T. Thompson, St. Louis, Mo.

It will be noticed that the paper list has been somewhat shorn from its usual proportions. In explanation of this fact, it was deemed best by your Executive Committee that this should be done, for the reason that the World's Fair is apt to detract from the attendance at the business meetings, and its attractions may possibly prove so strong to a majority of our members that our usual two days' session may be abbreviated to such an extent that there will not be time for the reading and proper consideration of more than the five papers above enumerated.

In reply to inquiries received regarding transportation rates, I would say that in answer to my request to the railway authorities that the customary reduction of rates be granted, I have received word that on this occasion no reduction from the regular fares will be made, other than those which may happen to be in effect at the time from various points to parties in attendance upon the World's Columbian Exposition.

For application blanks, copies of by-laws and detailed information not embodied in this notice, please apply to the undersigned.

A. W. LITTLETON, Secretary.

American Gas Light Association.

OFFICE OF THE SECRETARY, PROVIDENCE, R. I., April 19, 1893.

To all Members of the Council:

By direction of the President, I hereby give notice that there will be a meeting of the Council of this Association on May 16th, 1893, at 7.30 P. M., at the Victoria Hotel, Chicago, Ills.

Every member of the Council is urgently requested to be present, as the business to be transacted not only includes subjects concerning the October meeting of the Association, and the special features due to the time and place, but also other matters which are of vital importance to the welfare of the Association. Respectfully,

A. B. SLATER, JR., Secretary.

BRIEFLY TOLD.

SECRETARY LITTLETON'S CURRENT NOTICE.—Secretary Littleton's second announcement respecting the Western's sixteenth annual meeting will be read with much interest, in that it not only shows that all the preliminary arrangements are being satisfactorily woven into a harmonious whole, but that the meeting from a technical standpoint is not to be in any sense subsidiary to the great exhibition, the opening days of which will have been well on when the gasmakers of the West—and a goodly lot, too, from the remaining "quarters" of the compass designation—will greet each other in the hall of the Western Delmonico. We do not like to say, or even to suggest that the "man from Quincy" is the least shade pessimistic; but it really looks that he tends towards the doubtful side in intimating that the paper list is briefer than it might be. Candidly, from a pretty close scrutiny of its numbers, we incline to the view that the five papers promised will furnish ample matter for discussion over a two days' session. The subjects, bar one, perhaps—and that one, while it is tuned to a trite tale, is in no sense old, since it is one that gas men will have always with them, while they are in the field for good, profitable business—are well out of the regular order, and introduce to us three new contributors. So it is but fair to assume that the Western's paper list is well up to standard, and that amusement—as is usual with the Western—will wait upon instruction. The five regular numbers, it must be remembered, will be introduced by President Chollar's inaugural, and from what we know of the man, ever of careful, methodical ways, always blended with a strain of humor, never offensive nor of the type *tintamarre*, his presentment of the past, present and future of the industry cannot be other than an honest reflex of the day and time. In fact, Mr. Chollar's "state paper" can be looked forward to with more than ordinary interest; for he is apt to say what he means, which means much when a man knows how to say these things properly—and that Chollar can do to a nicety. To be sure the Fair will be a magnet, and it ought to be; for so far it has been schemed and plotted on a scale completely commensurate with the industries of the States, and of the world, that it aims to array in object photographic fashion. One sting in the announcement is the acknowledgment that the "Trunk Lines" refuse to make the usual concession in railway fares; still we do not suppose that many will grumble over the desire of the railroads to turn an honest penny. The fraternity on this side of the Ohio should not be led into the belief that there will be any great difficulty in securing accommodation in Chicago, at rates that will be fairly reasonable. Let them write in time to the proprietors of the hotels named in Secretary Littleton's list, and they will be taken care of. But they should not expect, under the conditions that will prevail in Chicago for the ensuing half year, to jump out of a Pullman into a bridal chamber of the best house in town, merely by travelling from the nearest railway depot and making off hand inquiry at the hotel man's desk.

A COUPLE OF HANDSOME PHOTOGRAPHS.—We are indebted to the thoughtfulness of Messrs. Bartlett, Hayward & Company, of Baltimore, Md., for two beautifully mounted photographs of the mammoth holder, constructed by them in 1892 for the Chicago Gas Light and Coke Company. The views, which are as excellent specimens of the photographer's art as any that it has ever been our fortune to inspect, show the holder fully cupped and out-of-sight (if we may so say), respectively; that is, the crown is visible, as is also all the solidity of the framework, trussing and other bracing paraphernalia, so the out of sight reference, apart from its slanginess, is out of order as a description of photograph No. 2. This holder, which is the largest up to date on the American Continent, is of the four lift order, rests in a brick tank, and has the following dimensions: Inner section, 179 ft. 6 in. by 42 ft. 9 in.; second section, 182 ft. by 42 ft. 3 ins.; third section, 184 ft. 6 ins. by 41 ft. 9 ins.; fourth section, 187 ft. by 41 ft. 3 ins. The tank is 190 ft. in diameter by 43 ft. 6 ins. deep. The working capacity of the vessel has proved to be 4,289,500 cubic feet. It is fitted with three 30 inch inlet and outlet pipes. Its strength and capacity for duty were fully tested during the past remarkably inclement winter season—which in Chicago was marked by an almost continual succession of gales of almost cyclonic fury, accompanied by an almost unrecorded lowness of thermometer—in that it answered every demand and fulfilled every requirement. It reflects great credit on the enterprise of those who ordered it, and is a noble testimonial to the engineering skill and constructive ability of the firm that erected it. In the near future we hope to give a minute or detailed description of the vessel.

THE COOKING EXHIBIT AT THE FAIR.—We are enabled to say that the movement in this State to collect a fund for the better illustration of the advantages of gaseous fuel as a cooking agent, the same to be exemplified by Miss Juliet Corson at the Columbian Exhibition, is taking on proportions that bid fair to cause it to become quite imposing. The New York City Companies are considering the advisability of lending a helping hand, and if their aid can be actually obtained, the gas men of the State, and of the country as well, may have cause for some show of pride over their representation at the Fair. We had hoped this week to report the names of the committee selected to take charge of the subscription, but are obliged to defer until Monday next. There will be no trouble in securing a gas supply in any of the buildings. The Chicago Company has attended to that.

THE proprietors of the Portsmouth (N. H.) Gas Company assert that their loss from the effect of the severe winter on main and service pipes amounts to not less than $5,000.

[From the *Journal of Gas Lighting.*]

The Comparative Cost of Gas and Electric Lighting.

References have recently been made by our Scotch correspondent to a paper on the above subject read by Mr. J. M. Turnbull, of Edinburgh, before the Merchants' Association of that city. We give below the principal portions of the communication.

In view of the recent adoption of the electric light by many towns, and its proposed introduction into Edinburgh, the present may be considered a very suitable time to consider its advantages and disadvantages, and what it is likely to cost as compared with gas lighting as we already have it. First, as regards the cost. As it is proposed to treat the subject from the consumers' point of view only, it is not necessary here to go into the cost of engines, dynamos, and other fittings required for an installation. We need only take it as charged to consumers, like any other article supplied commercially.

It is somewhat difficult to arrive at what would be an average price for electric current, as estimates for proposed installations, and the prices charged in localities where it has already been introduced, vary so much. To get at this, and to come to as fair a conclusion as possible, I will take the estimates and statements of electricians themselves, and also the actual prices charged in towns in which the electric light is already in use. As technical knowledge concerning electrical matters has hitherto been confined to a few, it has given room for many parties whose knowledge of it was exceedingly small to talk a great deal of mysterious nonsense and sentiment regarding it; and, if these statements were believed, there is hardly anything that electricity would not accomplish. As, however, knowledge concerning it is being very rapidly extended, the proper and most economical uses it can be put to are being found out, and the sentiment and humbug formerly talked about it will shortly disappear. When any of the authorities in electrical matters are asked as to its cost for lighting, the answer is generally very indefinite. If an approximate answer is given, it is generally "about the same price as gas;" "about 10 per cent. dearer than gas;" "taking it all around, it will not quite compete with gas." Some electrical engineers have even stated it as "about 30 per cent. dearer than gas."

In order to show how neatly the question of cost is evaded by electrical experts, I will quote from the prospectus of a company recently promoted for the supply of electricity to Coatbridge: "The question of the price at which the current could be supplied has been the chief one raised by intending consumers. They are willing to pay the present price of gas, light for light. In this connection, the following figures, given by Mr. W. H Preece, Chief Electrician to the Post Office, in a recent address, will doubtless be of interest: 'A pound of coal distilled into gas (in Manchester) gave a light of 17.2 candles, while a pound of coal converted into electrical energy would give 48 candles with a glow light, and 288 candles with an arc light'" In the same address Mr. Preece also stated, as a result of his practical experience with more than 70 lamps, that "he was not paying more than when he had gas burners." It will be observed that they do not (although they quote the price per unit in six other towns) give the price at which they intend to supply the unit, but round off their indefinite statement by an entirely misleading quotation from an address by a scientific man. Mr. Preece neglects to state that there are residuals in gas manufacture. In Edinburgh, last year, coal for the gas works cost £112,975; but, out of this, there was recovered for residuals £26,686, or 26¼ per cent. Now, if an engineer who is asked to give an estimate were to neglect to take 26¼ per cent. into consideration, you would say that he was misleading you; and I say that Mr. Preece is not stating the case fairly. If the prices which have been fixed in the towns in which electric light has been introduced are taken, the cost at which electric current can be at present supplied will be arrived at. I take the prices charged in 15 towns, and the average comes out at 7½d. per unit; but that there may be no stretching of the figures, I will take 7d. as the unit. In order to make a fair comparison with gas, I will take one of the best known forms in which the electric current is used—that of the 16 candle incandescent lamp, which is known as the 60-watt lamp, because 60 watts passed through it per hour at 100 volts pressure will give a light of 16 candles. I take the supply of current for 1,000 hours, which may stand for about a year's lighting. A Board of Trade unit is made up of 1,000 watts; therefore it follows that in 1,000 hours a lamp will require 60 units. These at 7d. per unit will cost £1 15s. This is not, however, all the cost. The lamp requires renewal. In view of the early expiration of patents, I will take the cost of a lamp, with the fixing of it, at 2s. 6d. But there is also the charge for a meter. Not to overstate, I will take the lowest hire I know of—that which it is proposed to charge in Dundee—of 15s. each. Taking an average of 10 lamps in a house, the charge upon each lamp would be 1s. 6d. In Liverpool it would be 3s. Adding the above figures together, we have a total charge of £1 19s. per lamp.

Now, as regards gas. The gas used in London, and in many other towns in England, is of 16 candle power; and it is charged at from 1s. 9½d. to 2s. 6d. per 1,000 cubic feet—the average charge, taking a number of towns, being 2s. 2d. Not to strain the matter, I will take the highest charge of 2s. 6d. If 16-candle gas be burnt at the rate of 5 cubic feet per hour, it will give a light of 16 candles. It will take 5,000 cubic feet to last 1,000 hours; and this quantity, at 2s. 6d. per 1,000 cubic feet, will cost 12s. 6d. But as in Edinburgh the gas in use is of 26-candle power, 615½ cubic feet of that gas will give a light equal to 1,000 cubic feet of 16 candle gas. Therefore, 3,077½, or, to put it in round numbers, 3,100 cubic feet of Edinburgh gas, will be equal to 5,000 cubic feet of 16-candle gas. Charged at 3s. 10d. per 1,000 feet (the present price in Edinburgh), the cost would be 11s. 10d—say, 12s. The light from the electric lamp would therefore cost £1 7s. more than that from the gas lamp. Electricity at 39s per lamp is consequently 3¼ times dearer than gas at 12s. With regard to incandescent lamps, however, many of them do not give the light they are said to afford, even to begin with; and before they have been long in use, their light is diminished by one-half, or even more. If this serious depreciation be taken into account, it will increase the cost of lighting one third or one-half; and it may easily be said, without stretching figures, that the expense of lighting by incandescent electric lamps is from four to five times that of lighting by gas.

A favorite delusion, both with those who know little about electricity, and also with those who know better, is that, if they have a private installation, and generate current by means of a gas engine, they will produce light much cheaper than if they lighted by gas. That this is a delusion, I will prove by a case that happened very recently. Some months ago, the Safe Deposit Company's vaults in London were lighted by gas; there being a steam engine at hand which was kept going for ventilation purposes. It was resolved to attach a dynamo to this engine, to produce current for lighting. Some statements were made in the *Journal of Gas Lighting* as to the cost at which the current was produced; and these were controverted by Mr. A. B. Gill, the engineer under whose superintendence the Safe Deposit premises were lighted. I will not enter into this. But Mr. Gill also stated that he had a private installation, worked by a gas engine, at his own house, and that he produced current at a cost of 1½d. per unit, and that the current lighted 16 lamps of 16 candle power each; the gas consumed being 50 cubic feet per hour, at 2s. 6d. per 1,000 cubic feet. Whether he made these statements to deceive other people, or whether he was deceived himself, I cannot say; but that he was utterly mistaken I will undertake to prove. In the first place, it would require a 2-horse power engine, working to 3-horse power, to produce that amount of current. The cost of engine, dynamo, lamps, wiring, and fitting up would be at least £150, the interest upon which, at 5 per cent. per annum, would be £7 10s. If 50 cubic feet of gas per hour were used, it would require, in a year (which, to give him every fairness, I will take at 1,250 hours), 62,500 cubic feet. This, at 2s. 6d. per 1,000 cubic feet, would cost £7 16s. 3d. In a great deal less than 20 years his engine would be pretty well worked out; and therefore 5 per cent., or £7 10s. a year, would require to be added. Other £7 10s. would be needed for oil, repairs, etc.; and £2 10s 8d. for renewal of lamps. These figures run up to £32 16s. 11d. Now, with gas, 16 burners consuming 5 cubic feet per hour, would in 1,250 hours use 100,000 cubic feet, which, at 2s. 6d. per 1,000 feet, would amount to £12 10s. Add £1 as the cost of burners and for depreciation of fittings, and the cost of the two lights would be: Electricity, £32 16s. 11d.; gas, £13 10s., or a difference of £19 6s. 11d. per annum in favor of gas. To put it in another way, he requires 2,500 Board of Trade units for his 16 lamps; and, in order that his lighting bill should be no more than it would be by gas, he would require to be able to produce current at a little less than 1½d. per unit, which would come to £13 0s. 5d. Here is another example of how electrical engineers compare electricity with gas. Mr. Robert Hammond is the author of a book entitled "Electric Light in Our Homes;" and in it he reckons up the cost of running electric light in the First Avenue Hotel as follows:

"Average of 230 lights per hour throughout the year—Wages, £450; coal, £400; renewal of lamps, £200; sundries, £200; keeping plant in perfect repair, £600—total, £1,850. Cost of illumination by gas—Average number of lights per hour throughout the year, 230; 24 hours × 365 days × 6 cubic feet of gas = 12,088,800 cubic feet of gas, at 3s. per 1,000 cubic feet, £1,813 6s. 4d."

He does not allow anything for interest or depreciation, which would be about £300 more; while the cost of gas, burning for 3,000 hours, with 16 candle gas at 2s. 6d. (not 3s., as he says), would be £512, or less

than a quarter the cost of the electric light. But it will be observed that he counts upon gas burning for 24 hours per day. With the arc light, much better results are obtained for the quantity of current used.

As to the cost of current, I will take two recent examples—Brighton and Glasgow. At Brighton, estimates were taken for 40 arc lamps to light the Marine Parade. These lamps were to use 30,000 units per annum, at a cost of £875. Each lamp would thus use 750 units, and would in all cost £21 17s. 6d. In Glasgow, the charge for each arc lamp has been fixed at £20. In neither of these particular cases can the charges be given as the results of practical trials; but in Bradford, where the light has been in use for some time, each lamp costs the Corporation £27 per annum. In Glasgow it is proposed to substitute one arc lamp for every three gas lamps. In Edinburgh, the public lamps are, on an average, about 30 yards apart. This would make the arc lamps about 90 yards apart. I believe that in some Continental cities the distance is about 55 yards. Let us see what the cost would be by gas. We have, in 90 yards, three lamps, each consuming 2 cubic feet per hour, or 6 cubic feet among them. Burning till midnight, they will be alight for 2,072 hours, and will each consume 4,144 cubic feet, and at 2s. 10d. per 1,000 cubic feet, the charge for public lighting will amount to 11s. 9½d. for each lamp, or £1 15s. 4½d. for the three. If the same amount were spent on gas as is proposed to be laid out upon electric lighting, instead of three lamps, each costing 11s. 9½d, it would provide 34 lamps. A lamp would thus be provided for rather less than every 3 yards of street, which, of course, would be ridiculous. Supposing burners to consume 4 cubic feet of gas per hour were employed, and two lamps were placed between every two existing lamps, we should have fourteen times the light we are at present getting, and the cost for the three lamps would be £8 4s. 5d., or not nearly half the cost of one arc lamp.

Now as to the advantages or disadvantages of the two lights. The advocates of electric lighting claim several advantages for their light. There is a good deal of difference as to what these are; but one on which they will agree is that it does not use up the oxygen in a room, or give off noxious fumes. This is quite true; but do we live under such conditions that we can say there is a scarcity of oxygen? Certainly not. To be "free as the air" is a common phrase. I wonder if those who recommend electric lighting in that way are ignorant of the fact that a fire in a room will consume twenty times the amount of oxygen that the gas required to light the room will do. They "strain at the gnat" of a gas jet, and "swallow the camel" of a fire. It is also claimed that the electric light does not blacken ceilings or destroy decorations; but this advantage can also be claimed for gas lighting, where regenerative lamps are used, if the products of combustion are led off.

The question of whether or not the electric light has been a financial success scarcely comes within the scope of this paper; but, as the subject is at present of the first importance for the Corporation of Edinburgh, perhaps I may be allowed to glance at it. Many electric light companies have been started which have not been a success. They have often been the stalking-horse for the promoter and the financier to ride; and, after struggling on for a while, they have, at last, found their way to the liquidator. "The year 1892 has been remarkable chiefly for the large number of working schemes which have been promulgated, and the few which have been carried out." So said the *Electrical Review* of Jan. 6 this year. The extract may be taken to read thus: Promoters are now rather shy; they have not reaped the golden harvest they expected, and those who are interested in the construction of electrical plant do not care to take the risk of starting companies, but prefer to press on corporations to undertake the work themselves. The Liverpool Electric Supply Company have been in existence for more than nine years; they charge 7½d. per unit, and their dividend is 4½ per cent. Their manager was candid enough to say that electric lighting did not pay them, and that any dividends they declared were earned as electrical engineers in putting in private installations in and around Liverpool. If anyone goes into the subject as I have done, he will come to the same conclusion as I have—that electric lighting is an exotic which requires careful nursing and fostering before it can come to much. No doubt improvements are being constantly made which will cheapen the supply. But the principle cannot be altered; and unless some discovery is made which will bring about a radical change, it can never be very cheap. Improvements are also being made in gas lighting, and when one of them—Mr. Young's new and ingenious method of enriching coal gas by means of paraffine oil—comes into general use, a reduction in price may be expected. And with the more general adoption of the consumption of gas by means of regenerative burners, it will not require to be afraid of any rival system of lighting.

Shaw's Apparatus for Detecting Gases in Mines.

The three principal gases, writes the *Colliery Engineer*, are firedamp, or light carbureted hydrogen (CH_4), chokedamp or carbonic acid gas (CO_2), and whitedamp or carbonic oxide (CO). The only practical method for determining the presence of carbureted hydrogen, until recently, was the action of the gas on the flame of a safety lamp. This method is still in use, and probably will be used for many years to come, to make what might be called "rough tests" at the working faces. The only practical test for the detection of carbonic acid was the action of the gas on a naked flame. The presence of the gas causes the flame to burn with less life, or extinguishes it entirely. Carbonic oxide, the most treacherous of the three gases, could not be detected by any practical means, and many men have lost their lives by unconsciously entering an atmosphere containing a very small percentage of this gas.

While great improvements have been made in past years in the construction of safety lamps, until we now have testing lamps of a high degree of sensitiveness, and others for working purposes that are not so sensitive, but safer for use continuously at the working face, we did not have any means of determining the exact point where a gas-charged atmosphere becomes ignitible until the Shaw gas tester was invented and perfected. This instrument will determine the proportion of gas necessary to render an atmosphere explosive to the narrow limits of $\frac{1}{10}$ of 1 per cent.

When we consider the fact that both chokedamp and firedamp may be present in the same atmosphere, and that the tendency of one is to lessen the flame and of the other to increase it, we realize that conditions of a highly dangerous nature may exist, even when the flame of a sensitive safety lamp appears to be normal. In such a case some other test is necessary to insure absolutely correct ideas of the condition of the air. In fact, there are so many instances constantly occurring at mines, when it is desirable to know exactly what the condition of the air is, that we have not space to enumerate them all. We, therefore, pass on to a description of Mr. Shaw's mechanism, and explain how the various tests are made. From this the intelligent mine official or miner can readily see how accurate and useful it is.

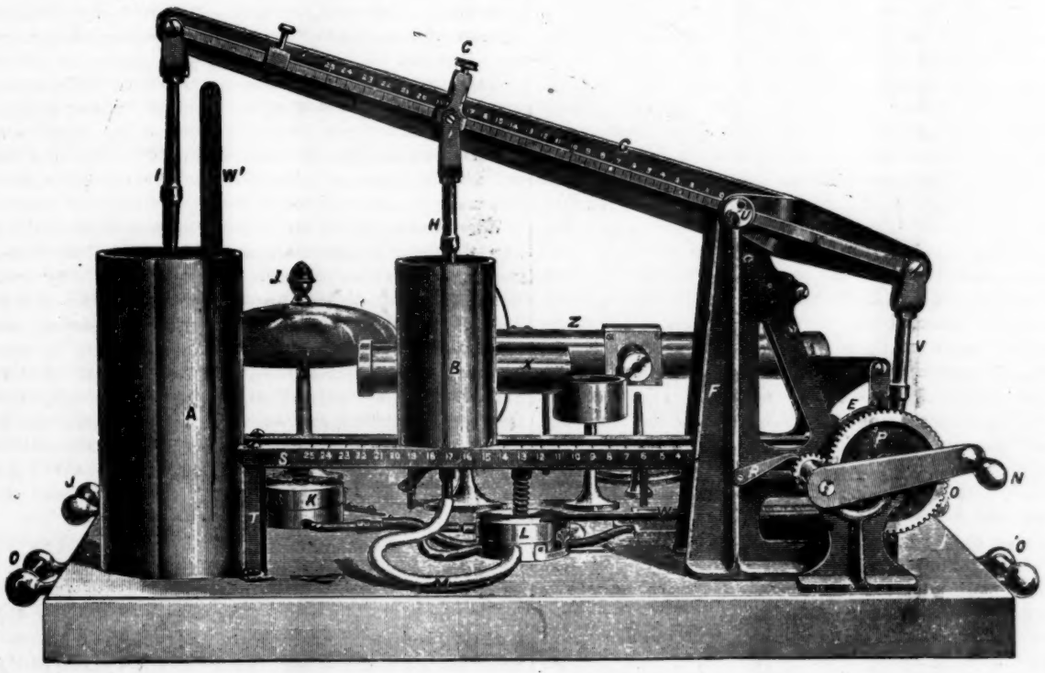
By referring to the cut, it will be seen that *F* represents two standards supported on an ordinary metal bedplate, and *G* represents a beam lever mounted on bearings at the top of the standards; the short end of the lever is connected by the connecting rod *V* with the crank disc *E;* the long end of the lever is connected by the rod *I* with the plunger head of the pump cylinder *A*, and the intermediate section of the long end of the lever is connected in an adjustable manner with the plunger in pump cylinder *B*, through the connecting rod *H*. The lever is vibrated in a vertical direction, a pre determined distance, by the crank disc *E*, actuated, through gearing *P*, by the hand crank *N*. The full stroke of the cylinder *A* equals 800 cubical centimeters, and that of cylinder *B* equals 266⅔ cubical centimeters.

The plunger of cylinder *A* is given a full stroke at each revolution of the crank disc *E*, whilst the position of cylinder *B* is made adjustable upon the supporting bars *S*, and secured in any position by an ordinary screw nut beneath the bars *S*. The cross head of the connecting rod *H* is arranged to slide upon the two projecting ribs of the vibrating beam *G*, and is secured in place by the clamping screw *C;* the beam and bars are marked with figures showing the exact percentage of the relation of the two cylinders to each other in cubical contents. The pumping cylinders are free from all ordinary check valves; the valve duties for both cylinders are performed by one single disc valve *L*. This valve consists of two discs with ground faces, the upper disc vibrating upon the face of the lower one, through an accurately determined distance. This valve is operated automatically by the connecting rod *W*. At the upstroke of the pumps two ports in this valve are open and an equal amount of air and gas would be forced through, if the arrangement of the cylinders was such as to take equal amounts. But as the cylinder *B* is smaller than cylinder *A*, and the stroke of the plunger connected with rod *H* is shorter than that of the plunger in cylinder *A*, only a certain proportion in volume of each is conducted into the cylinders. It is well to state here that the gas or mixture to be tested is conveyed by a rubber tube to one of the ports of the disc valve *L*. On the up stroke of the pumps, cylinder *A* is filled with air, and cylinder *B* with the gas or mixture to be tested. On the down stroke the ports in disc valve *L* that were open on the up stroke are closed, and opposite ports are opened. Through these the air and gas, or mixture, is forced to a mixer, where they are thoroughly mixed with each other. The resulting product of mixed gases are led by a tube to a central port in the hand valve *K*, from which it is conveyed to tester *Z*. This is the case in testing ignitible gases. This tester is of the highest importance, as it is the instrument

that solves the problem of giving quick and positive tests of all percentages of ignitible gases in the air, and for determining values of pure and mixed ignitible gases to the smallest desirable fraction. For testing chokedamp the hand valve K is set so that a different port is opened, and the mixture, instead of being conveyed to the tester Z, is conducted to the tester X. If the handle of the hand valve is turned so that the arrow points to $F\,D$, the mixture will be conveyed to the firedamp tester Z, and if turned so that it points to $C\,D$ the mixture is conveyed to chokedamp tester X.

Tester Z consists of a square metal valve box supported upon metal pillars. This box is provided with screw threads for the reception of brass cylinders. The cylinder to the right of the square box is provided with a perforated cap end, while the one to the left is provided with a piston valve held under slight compression by bow springs and wire thread with an adjustable lever and weight to regulate the tension.

The mixed ignitible gases for test are led into the tester under slight pressure, and blown against the piston valve, from which point they flow backward, expelling any previous air or gas out the aperture in the perforated cylinder head, and out an igniting nozzle against the flames of a small lamp. The mixed gases blowing through the flames are caused to unite at the lowest ignitible point, and about 4 per cent. below the explosive line, at which point there is sufficient expansive effect of the combined gases in the test cylinder to propel the piston valve against the gong J, causing an unmistakable sound, which occurs always at a certain definite fraction of the percentage of the gas tested, and which point is made a standard for comparison for all other percentages of the same gas.



This description, owing to lack of space, is a very general one. The many fine points of adjustments, and minor portions of the mechanism are not described, as they can be only appreciated by a personal inspection of the instrument.

If it is desired to test the gas taken from a mine, for firedamp, a supply of the mixture existing in the mine is secured by pumping it into a rubber bag by means of an ordinary small diaphragm pump and brass tube fitting the mouth of the bag. As soon as the bag is filled it is corked and taken to the testing machine on the surface, and a cork with a tube and ordinary stopcock replaces the first cork. This is then connected by rubber tube to the disc valve L. The gas cylinder B is set at the point marked 6 per cent. on the beams for the first test of gas of unknown quality. The crank handle N is operated by hand, giving two or three strokes of the pumping cylinders, the combined action of which forces 6 cubic inches of gas from the rubber bag with 94 cubic inches of atmospheric air through the mixer, to the tester. If the lowest point of ignition is sufficient to cause the gong to ring, by the expulsion of the piston valve, it would determine the presence of pure light carbureted hydrogen gas of rich quality.

When tests of air containing low percentages of firedamp are required, any ignitible gas is first taken in a rubber bag, and its lowest point of ignition when mixed with air is determined. The clamp D on the beam G is moved to the point at which the small cylinder B was located when the lowest point of ignition was determined, or 6 per cent., and clamped. The cylinder B is then shifted to a point marked one per cent. less than the point marked by the clamp, or 5 per cent. At this point the instrument can be operated without any possible sound from the gong, because the quantity of gas is decreased. If, when the air from the mine is forced through the machine and mixed with the standard gas taken, the gong rings, it is known that there is more than one per cent. of explosive gas in the mine air, so a smaller proportion of the standard gas must be taken, by moving the cylinder B back to 4½ per cent., and again opening it. If the gong rings from a faint blow of the piston valve, it is known that the test is nearly completed, and the line of demarkation nearly reached. If by moving the small cylinder one-tenth of one per cent. nearer the fulcrum, or to 4.4 per cent., it is found that the gong does not ring when the machine is operated, it is evident that the air from the mine contains the difference between 6 per cent. and 4.4 per cent., or 1.6 per cent. of pure light carbureted hydrogen.

The tests for firedamp are all simple, and depend entirely on the mixing of air to rich samples until the lowest point of ignition is found, and then adding to this the percentage of air used. This will give the percentage of pure gas in the mixture. If the sample is weak in gas, a standard gas whose point of ignition has been previously determined must be mixed with the sample tested, and the proportion of this standard gas taken must be subtracted from the previously determined point of ignition. The remainder will accurately show the percentage of gas in the sample tested.

To test safety lamps it is only necessary to remove the cap from the chokedamp tester X, and attach to it a glass bell jar, with a rubber tube. Under this bell jar place the lighted safety lamp, and pump on it any percentage of illuminating or other ignitible gas (an explosive mixture from the mines is best), and watch the effect. For best results safety lamps should be tested in absolute darkness.

In testing for chokedamp, a standard glass tube containing lime water, representing the turbidity caused by one-half of the large cylinder full of air containing one per cent. of carbonic acid gas (which is furnished with the machine) is used. Now, if in another tube of lime water $\frac{50}{100}$ of a cylinder of the air tested caused the same turbidity, it is evident that the sample tested contained 2.5 per cent. of carbonic acid gas, because $50 \div 20 = 2.5$. The graduated scale W^1 is used to measure the proportion of the stroke at which such turbidity was attained, or in other words it measures the quantity of the sample pumped into the cylinder A.

The test for whitedamp, or carbonic oxide, is more complicated than the tests for firedamp or chokedamp, but can readily be learned by a

a man of average intelligence. Our space is too limited to describe it here so we will merely state that it is very similar to the test for chokedamp, the principal differences being in the chemicals used for the fluid in the standard and test tubes.

The test for sulphureted hydrogen is, like that for whitedamp, slightly more complicated than the other tests, but it is not a difficult one to understand.

Gas Engines and Electric Lighting Plants.

J. Emerson Dowson, in a paper referring to the use of gas engines as motor powers for electric lighting stations—the paper was read before the British Institute of Civil Engineers—remarked that gas engines aggregating 7,000 horse power were in use in electrical plants in Great Britain, and that in Germany they were also coming into quite general use in this line. Several plants were described in which gas engines were used. One of these, the central station at Dessau, belonging to the German Continental Gas Company, was opened in 1886. It had two 60 horse power, one 30-horse power and one 8-horse power engines, worked with town gas, and all the dynamos were driven by belting and countershafts. In 1891 alterations were made. One 60 horse engine with its belting and countershaft was retained, and one of 120-horse power was introduced, coupled direct to its dynamo. The speed of the engine and coupled dynamo was 145 revolutions per minute, and the consumption of gas was equal to 39 cubic feet per kilowatt hour. Since February, 1889, the municipality of Schwabing, a suburb of Munich, has used an Otto engine worked with Dowson gas for 10 arc and 300 incandescent lamps. The load was variable, but with an average output of 22.5 kilowatts per hour, the fuel consumption was 3.3 pounds per kilowatt hour. The town of Morecambe was lighted by nine arc lights and incandescent lamps, equal to 1,600 of 8-candle power each, the dynamos being driven by Stockport gas engines worked with Dawson gas. With an output of only 1,155 kilowatts per week the consumption of fuel was 2.58 pounds, and the cost of the gas, including wages and fuel, was ¼d per kilowatt hour delivered. At the chateau of M. Say, at Longpont, in the South of France, there were 650 incandescent lamps and one arc light supplied by a dynamo driven by a Crossley engine worked with Dowson gas. The consumption of fuel was 1.2 pounds per indicated horse power hour and 2.7 pounds per kilowatt hour. It was believed that the late Sir William Siemens first drew attention to the fact that when illuminating gas was burned in a gas engine to drive a dynamo, much more light was produced electrically than could be produced by burning the same quantity of gas in burners in the usual way. Latterly the consumption of gas per horse power hour in gas engines had been reduced, and the ratio was at the present time about 20 to 1 in favor of converting the gas into an arc light by means of a gas engine. The author had collected data from various sources as to the consumption of ordinary town gas by engines supplying electric light, with or without accumulators. The average of all the returns, with engines under varying loads and without accumulators, was about 47 cubic feet per kilowatt hour; when accumulators were used the consumption of gas was less, because the engines then worked under a full load. With 47 cubic feet per kilowatt hour, and 55 watts per 16 candle power, one light of that power required only 2.6 cubic feet per hour, whereas a standard argand burner required five cubic feet per hour. In this comparison it was assumed that the incandescent lamps and gas burners were in good order; but under ordinary working conditions they did not maintain so high a duty.

The question of load-factor was a serious one with any type of engine, but with gas engines the loss was much less than with steam engines. When a gas engine was stopped, its consumption of fuel stopped also, and there was no furnace to maintain; nor was there any water to boil at starting. At the same time, it was desirable that the gas engine should be worked as much as possible under a full load, and in this respect the experience at Dessau was generally confirmed. A central station was worked under trying conditions, and in the London district there was only a full output of current during from three to five hours in every twenty-four; moreover, about 60 per cent. of the total output was required during that short period. In practice, this meant that in a station where the current was supplied without accumulators the engines were run at a reduced speed during a portion of the time, and at other times some of them were stopped altogether; but all had to be ready to work in the evening, and occasionally in the daytime when there was fog. Generally, it might be assumed that the average consumption was more than 6 pounds per kilowatt hour where accumulators were used, and about 9 pounds to 12 pounds where they were not used. In any case, with the best possible arrangement of steam power, there must be a large amount of fuel consumed which did no useful work; for, even if some of the fires were drawn, they had to be relighted, and the large quantity of water which had cooled during the time of standing must be reheated.

With a large gas engine 1 British horse power per hour could be obtained with a consumption of 1 pound of anthracite, or 1½ pounds of coke; whereas the consumption of coal with the steam engines used for central stations must be taken at about 2½ pounds per British horse-power, when working under a full load. A saving of not less than 50 per cent. could therefore be effected in stations where the engines were fully loaded; and, where there were great fluctuations in the output, the loss of fuel with boilers not used, or only partly used, could be almost entirely avoided. For a maximum output of 400 kilowatts there would be three gas generators, each capable of supplying one third of the maximum required. The production of gas could be raised or lowered in several ways, and the working of each generator could be stopped immediately by shutting off its steam supply. Supposing, therefore, that all three generators were working at their maximum rate, and a gradual reduction was required, this could easily be effected; and, when the production of one or two generators could be dispensed with, their operation was at once stopped. The third generator could then be kept at work, and its production adjusted to suit the minimum consumption required. A gas generator had a small grate area compared with that of a boiler, and much less cooling surface; it contained no water, and required no chimney draught. A generator of the size referred to lost only 6 to 8 pounds per hour while standing. If an average of only 40 per cent. of the maximum power were required for 21 hours, it was equivalent to letting two of the generators stand for that period; and at 8 pounds each per hour that meant a total loss of only 300 pounds, compared with the much greater waste when steam power was used.

When town gas was used for driving the engines of an electrical station, the consumption was abont 50 per cent. less than the volume of gas required to give the same amount of light by ordinary burners. When town gas was used, neither boiler nor fireman was required, and there was no ashes to remove; less space was needed; no accumulators were required, except such as might be necessary to equalize the load of the engines, and to provide for a small amount of storage. The engines could be worked in the most crowded districts, close to where the lights were required, and where boilers were not allowed. When generator gas was used the consumption of fuel under a full load would be at least 50 per cent. less than with steam power, and the loss due to steam boilers not being fully worked could be almost wholly avoided.

The System of Electric Car Lighting on the Jura-Simplon Railway.

A writer in the *American Engineer and Railroad Engineer* says that after many experiments the Jura Simplon Railway have adopted two types of lamps for use in their electric system of lighting, to wit: Lamps of 10 candle power for lighting the interior, and lamps of 5 candle power for lighting platforms and toilet rooms. The lamps of 10 candle power are of the oblong form, those of 5 are round; they are all attached to the ceiling of the car inside of a hemispherical glass globe, such as is used for gas lighting. The heat developed by the lamp causes very rapid deterioration; they have, therefore been placed under the ventilators, so that they are continually cooled by the ascending current of fresh air.

Above the lamp there is a convex reflector, which diffuses the light below it better than can be done by one of concave form. The accumulators are placed in a box beneath the floor of the car. This box is closed by a shutter which turns up vertically, and is composed of two smooth pieces of wood furnished with contact plates, which are soldered to the ends of the main wire which feeds the lamp in the car. When the tray containing the accumulators is put into this box, the two bars attached to the poles of the battery come in contact with the two strips of wood, so that the connections are automatically made. The lighting and extinction of the lamps are done by means of a switch on the main wire that is fastened to the outside of the car near the brake van. This switch can only be moved by means of a special key, which is carried by the trainmen. In each first-class compartment there is a special cut off identical with the main cut off and led into a branch wire from the lamp.

This cut off permits the lamp to be put out when the apartment is unoccupied.

At first the passenger had facilities for regulating the intensity of the light for himself. This was done by placing two lamps of 5 candle

power each in each compartment instead of one of 10. A special switch permitted the two lamps to be put in series, which gave faint light, or in parallel, which gave the normal light; but the trials were unsatisfactory and the method was abandoned.

The cut off circuit consists of simple lead plates which are placed in the feed-wires of each lamp, the general cut-off being a fusible wire placed by the side of the box which carries the battery, in order to avoid the dangers which would result from an abnormal rise in the intensity of the current. The accumulators used on the Jura-Simplon are of the Huber system. Each battery is composed of an ebonite case hermetically sealed, provided with ventilators and divided into three compartments, each inclosing an element formed of five plates. The battery contains nine elements connected in series.

The plates of each of them are formed by an unoxidizable alloy of lead and antimony. The plates are filled with the oxide of lead for the positive plate, with litharge for the negative plate. The pastilles are perforated, which permits them to expand freely toward the center without putting any strain on the lead grid; each element gives a tension of two volts. The capacity of the battery is about 120 ampere hours, or $120 \times 18 = 2{,}160$ watts' hours. The maximum power of the discharge is about 5 amperes, and the normal discharge is 9.3 amperes, which corresponds to a power of about 170 watts. As the lamps used consume three watts per candle power, the intensity necessary for a difference of potential of 18 watts is .17 amperes, so that the battery can furnish 120 ampere hours = 705 candle power hours.

The normal power of the discharge of the battery being 170 watts, it can furnish lamps having a total luminous intensity of 171 watts ÷ 3 watts = 56 candle power, and the total duration of the lighting will be $\frac{705}{56}$ = 12.6 hours.

The total luminous intensity of all the lamps of a car having now been brought from 30 to 35 candle power, according to the type of the car, the available duration from the battery is from 23 to 20 hours. First-class cars with three pairs of wheels running in international service are provided with lamps having a total luminous intensity of 70 candles, and these cars are also provided with two batteries of accumulators coupled up in parallel, so that the total duration of 20 hours can be obtained; the battery weighing 242 lbs. can be easily carried and put into place by two men. The weight is subdivided as follows. Case and liquid, 83.6 lbs., and plates, 158.4 lbs. The capacity of the battery being, as has been said before, 2,160 watts hours, the weight is equal to .112 lbs. per watt hour of capacity. This result is better than that which was obtained in the lighting done by the German Railway Commission in Frankford-on-the-Main.

On each box there is a notice giving the number of hours, which must not be allowed to be exceeded before the battery is recharged. There is also an electro mechanical clock which is set in motion when the lamp circuit is closed. The dial of the clock shows the number of hours during which the accumulators have been furnishing the current. It is divided into 30 hours, and has a red pointer, which indicates the starting point. This very simple arrangement permits the inspector to tell at a glance whether there is any necessity for recharging. Each time that is done the clock pointer is set at zero. The principal stations are also provided with a supply of large accumulators. The accumulators are handled at the station on a four wheeled truck, carefully hung, so that there is no danger of shocks. The tray which contains the accumulators can be placed upon the ground, without any danger of short circuiting, since the contacts are some distance from the bottom. In order to avoid all causes of loss of electricity resulting from contact with damp objects, as well as to prevent shocks during the transportation of the accumulators from the truck to the car, occasioned by the splashing of the liquid, a litter is used for this purpose. When the battery is replaced, after having been working for the time marked on the car, a memorandum is made of the hour marked by the pointer, and the clock-work is set back so that the pointer indicates zero. The box is closed by raising the sash, which pushes the tray of accumulators back against the back of the box by means of rubber cushions, which prevent any sudden displacement, and also take up shocks due to the motion of the car. According to the report furnished by the company, the cost of this system of electric lighting is as follows: The available capacity of a battery is 2,160 watt hours; admitting the effectiveness of 70 per cent., it will be necessary to charge it with 3,100 watts. The power at Fribourg is delivered to the shaft of the dynamo at a cost of one cent per horse power hour, admitting an effectiveness of the dynamo of 90 per cent. and of the wiring 95 per cent. The cost rises to about 1.2 cents per horse power hour. The kilowatt hour then costs about 1⅛ cents per hour; the charge in the battery being 2.16 kilowatts, for which the effective charge of 3.1 kilowatts is necessary, the cost of the battery is 5⅝ cents.

Coming now to the first cost, it will be divided under three heads: That of the electrical energy, the maintenance of the apparatus, and labor. As for the electric energy in a car lighted by the means of six incandescent lamps, with a total intensity of 50 candle power, the amount of energy acquired would be 150 watts for an average lighting of five hours per day, or 1,825 hours per year, the energy consumed will be 273.7 kilowatt hours, and the annual cost of lighting is about $5.

Maintenance of the Apparatus.—The lamps have the durability of 600 hours, each lamp must therefore be replaced three times a year, counting upon an average lighting of five hours per day. Lamps cost 40 cents. The expense of renewing will therefore be $7.20. The company manufacturing accumulators charge $5 per year for accumulators for maintenance. At the end of five years the company agree to replace the accumulators to the Jura-Simplon road on a basis of a depreciation in their value of 8 per cent.

As the battery costs $66, and the annual depreciation is 8 per cent., we have the annual cost for depreciation of $5.28. The general plant of Fribourg cost about $4,000. We may take 40 per cent. of this, or $1,600 as applicable to that portion of the plant which is especially adapted for charging the accumulator. We may also take $1,260 as the cost of the car and equipments, giving a total expense of $2,860. This expense being divided among 120 batteries gives $23.50, of which interest and depreciation rated at 5 per cent., amount to $1.17. Finally, the car apparatus being estimated at an average cost of $50, with interest and depreciation for the same at 5 per cent., we have $2.50. The total expense for the maintenance and depreciation of the car is therefore $33.01.

The expense for labor is about the same as that for lighting with oil, or $5.40 per year. The lamps would thus have an expense of $32.40 per car per year. Adding the above, we have

Electrical Energy	$5.00
Maintenance and depreciation	33.01
Labor	32.40
	$70.41

These figures show that the cost of electric lighting by means of accumulators in Switzerland is far less than the cost of their method of oil lighting, but it would be imprudent to jump to the conclusion that electricity is the most economical method of lighting; since the Swiss are in a particularly favorable situation for electric lighting, as the current is furnished at the extremely low price of one cent per horse power hour.

The conclusions reached are that electric lighting for European cars is not practical by lighting each car with its own accumulator. Each compartment should possess two lamps, so that in case one is extinguished the other can furnish the necessary light, and recourse to lighting by candles or lamps should not be permitted.

Concerning the choice of the source of electricity, it is only by experiment of long duration that the system and style of accumulators best adapted for the work can be decided upon. The very fact that improvements have been made in accumulators in the past few years show that there is still room for further advancement, both from the standpoint of their durability and resistance to vibratory shocks. Finally, it is not probable that electric car lighting can be practically introduced, except where the company can purchase the current at very reduced rates, or where they are already provided with their own generating stations.

The Cost of Steam Power with Engines of Different Types.

[Read by Mr. Charles E. Emery, Ph.D., at the New York meeting, March 21, American Society of Civil Engineers.]

A previous paper on this subject, read in 1883, is still substantially correct, but prices have changed. The present paper compares the cost of a unit of 500 net horse power from several representative types of engines. The speed has been assumed in all cases to be delivered at 250 to 350 revolutions of high speed engines and jack shaft speed of slow engines.

Expenses independent of coal are fairly constant, independent of the type of engine, and without considering interest or dividends, will in some cases equal the cost of coal. Comparing two economical engines, one effecting a saving of coal compared to the other of, say, 12½ per cent., makes the relative costs of fuel as 8 to 7; but if additional costs equal to the former be added to *both*, the relative economies will be 16 to 15, and the saving reduced to 6¼ per cent. simply by the summation

of costs. If all expenditures should pay 10 per cent. dividends on capital invested, and 10 per cent. of the difference in first cost of the engines equals an amount which represents a saving of 6¼ per cent. of fuel, then the cost to the owner of the steam plant will be exactly the same in the two cases, since in one case he will pay in additional interest or dividends on the capital invested the same sum as he will pay for additional fuel if he uses the cheaper engine. The cumulation of costs, other than for fuel or interest, reduces the saving due to economical consumption of fuel, and interest and dividends may neutralize percentages already made small from the first named cause. Original cost of plant is important where on one hand money is dear, or coal is cheap, or work irregular. When interest charges are considered, the number of hours an engine operates in a year has a very important influence on the question of first cost, as such charges for a given steam machinery will be exactly the same whether the latter be operated 1 hour per day during part of the year or 24 hours per day for the entire

TABLE I.—*Comparate Cost of Steam Power in Engines of Different Types.* By Charles E. Emery, Ph.D., New York, 1893.

a	b.	c.	d.	f.	g.	h.	i.	j.		m.	n.
Designation.	Type of Engine.	Indicated Horse Power to Produce 500 H.P. Net on Engine Shaft.	Steam Pressure by Gauge. Pounds per Square Inch.	Feed Water per Indicated Horse Power per Hour. Assumed.	Commercial Horse power of Boilers. One C.H.P. Equals Evaporation 30 lbs. Water at 70 lbs. Pressure from Temp. 100°.	Approximate Cost per Net Horse Power.				Water Evaporated per Pound of Coal.	Coal per Indic't'd Horse Power per Hour.
						Engines Erected and Connected.	Boilers Erected and Connected.	Buildings and Chimney.	Total with 2½ pr. Ct. Inspection and 6 pr. Ct. Interest During Construction.		
	Name.	I. H. P.		Lbs.	C.H.P.	Dols.	Dols.	Dols.	Dols.	Lbs.	Lbs.
A.	Simple high-speed non-condensing	542	100 to 120	33	596	17.50	26.22	15.18	63 91	8 5	3 882
B.	" low " " "	556	100 to 120	29	537	25 00	23.63	14 22	68.19	8 5	3 412
C.	Compound high-speed non-condensing	542	100 to 120	26	470	21.00	20 68	13.13	59 47	8 5	3.059
D.	Special triple-compound high-speed non condensing	542	150 to 170	24	434	26.00	21.70	12.55	65.37	8.5	2.824
E.	Simple high-speed condensing	542	100 to 120	22	397	21.00	17.47	11.95	54.71	8.5	2.588
F.	" low " "	556	100 to 120	20	371	27 00	16.32	11.53	59.51	8.5	2.353
G.	Compound high-speed condensing	542	100 to 120	20	361	24 50	15.88	11.36	56.14	8 5	2 353
H.	" low " "	556	110 to 125	18	334	30.00	14.70	10.92	60.35	8.5	2.118
I.	Special triple compound high speed condensing	542	150 to 170	17	307	29.00	15.35	10.49	59.50	8.5	2.000
J.	Triple compound low-speed condensing	556	150 to 170	16	297	37.50	14.85	10.32	68.00	8 5	1.882
K.	" " " " "	556	160 to 170	15	278	45.00	13.90	8.35	72.97	8.5	1.765
L.	Do. for probable maximum results	556	160 to 170	14	259	45.00	12.95	8.15	71.72	9.5	1.474

TABLE I.—*Continued.*

a.	o.	p.	q.	r.	s.	t.	u.	v.	w.	x.	y.	z.	A.	B.	C.	D.	E.	F.
Designation.	Tons of Coal (2240 lbs.) per Day, with Coal for One Hour Added for Starting and Stopping Fires		Cost of Coal per Horse Power per Year.								Cost per Net Horse Power per Year.				Insurance, Taxes, Renewals. Total, 5 per Ct of Cost.	Interest, 10 per Cent. of Cost	Total Cost per Horse Power per Year, all Expenses Except Coal.	
			308 Days, 10 Hours—Cost of Coal per Ton of 2,240 Pounds, Delivered.				365 Days, 20 Hours—Cost of Coal per Ton of 2,240 Pounds, Delivered.				Supplies and Repairs.		Wages.					
	10 Working Hrs. per Day.	20 Working Hrs. per Day.	$2.00.	$3.00.	$4.00.	$5.00.	$2.00.	$3.00.	$4.00.	$5.00.	308 Days 10 Hrs.	365 Days 20 Hrs.	308 Days 10 Hrs.	365 Days 20 Hrs.			308 Days 10 Hrs.	365 Days 20 Hrs.
	Tons.	Tons.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.
A.	10.332	19.725	12.73	19 09	25 46	31.82	28 80	43 20	57.60	72 00	2.96	7.01	4.78	11.34	2.95	6.39	17.08	27 69
B.	9.316	17.785	11.48	17.22	22.96	28.69	25 97	38 95	51.93	64 92	2.53	5 99	4.49	10 65	3.14	6 82	16.98	26 60
C.	8.142	15.544	10.03	15 05	20.06	25.08	22.69	34.04	45 39	56.74	2.96	7.01	4.16	9.87	2 74	5.95	15 81	25 57
D.	7.516	14.349	9.26	13.89	18 52	23.15	20.95	31.42	41.90	52.37	2 96	7.01	3.99	9.45	3.01	6.54	16.50	26.01
E.	6.888	13.150	8 49	12.73	16.97	21.22	19.20	28.80	38.40	48.00	2 96	7 01	3.81	9.02	2 52	5 47	14 76	24.02
F.	6.425	12 265	7.92	11.87	15 83	19.79	17.91	26 86	35 81	44.77	2 53	5.99	3 68	8.71	2 74	5 95	14 90	23.39
G.	6.263	11.956	7.72	11 57	15 43	19.29	17.46	26 18	34.91	43.64	2 96	7.01	3 63	8 60	2 59	5 61	14 79	23 81
H.	5.783	11.040	7 13	10 69	14 25	17.81	16.12	24.18	32.24	40.30	2.53	5 99	3.49	8.28	2.78	6.04	14 84	23 09
I.	5.323	10.163	6.56	9.84	13.12	16.40	14 84	22.26	29.68	37.10	2.96	7 01	3.36	7.97	2 74	5.95	15.01	23.67
J.	5.139	9.810	6.33	9.50	12 66	15.83	14 32	21.48	28 65	35.81	2 53	5.99	3 31	7.85	3 13	6 80	15.77	23.77
K.	4.819	9.200	5.94	8.91	11.87	14.84	13 43	20.15	26.86	33 58	2 53	5 99	3 22	7.63	3.36	7.30	16.41	24.28
L.	4.025	7.683	4.96	7.44	9.92	12 40	11.22	16.83	22.43	28.04	2.53	5.99	3 74	8.87	3.31	7.17	16.75	25.34

TABLE I.—*Continued.*

a.	G.	H.	I.	J.	K.	L.	M.	N.	O.	P.	Q.	R.	S.	T.	U.	V.	a.
Designation.	Total Cost per Net Horse Power per Year.								Total Cost per Net Horse Power per Year for Electric Railroad or Variable Work Requiring 50 per Cent. Extra Plant to Obtain 500 Horse Power Average. Insurance Increased to 1½ per Cent., Engine Renewals to 4 per Cent., and Boiler Renewals to 5 per Cent.								Designation.
	308 Days of 10 Hours—Cost of Coal per Ton of 2,240 Pounds.				365 Days of 20 Hours—Cost of Coal per Ton of 2,240 Pounds.				308 Days of 10 Hours—Cost of Coal per Ton of 2,240 Pounds.				365 Days of 20 Hours—Cost of Coal per Ton of 2,240 Pounds.				
	$2.00	$3 00	$4.00	$5.00	$2.00	$3.00	$4.00	$5 00	$2.00	$3.00	$4.00	$5 00	$2.00	$3.00	$4.00	$5.00	
	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols	Dols.	Dols.	Dols.	Dols.	
A.	29.81	36.17	42.54	48.90	56.49	70.89	85.29	99.69	35.45	41.82	48.19	54 55	62.14	76 54	90.94	105 34	A.
B.	28.46	34.20	39.94	45.67	52.57	65.55	78.53	91.52	34 55	40.28	46 02	51.75	58 65	71 64	84 61	97 60	B.
C.	25.84	30.86	35.87	40.89	48.26	59.61	70.96	82.31	31.10	36.12	41 13	46.15	53 52	64 87	76.22	87 57	C.
D.	25.76	30.39	35.02	39.65	46 96	57.43	67.91	78.38	31.65	36.28	40.91	45 54	52.85	63.32	73 80	84 27	D.
E.	23.25	27.49	31.73	35.98	43 22	52 82	62.42	72.02	28 08	32.32	36 56	40 81	48.05	57 65	67 25	76 85	E.
F.	22.82	26.77	30 73	34.69	41.30	50.25	59 20	68.16	28 12	32.07	36 03	39.99	46.60	55.55	64 50	73 46	F.
G.	22.51	26.36	30.22	34.08	41.27	49.99	58 72	67.45	27.48	31.33	35.19	39.05	46.24	54 96	63.69	72.42	G.
H.	21.97	25.53	29.09	32.65	39.21	47.27	55.33	63.39	27.36	30.92	34.48	38.04	44 60	52.66	60 72	68 78	H.
I.	21.57	24.85	28.13	31.41	38 51	45.93	53.35	60 77	26.92	30.20	33.48	36.76	43 86	51.28	58.70	66.12	I.
J.	22.10	25.27	28.43	31.60	38 09	45.25	52.42	59 58	28 27	31.44	34 60	37.77	44.26	51.42	58.59	65.75	J.
K.	22.35	25.32	28.28	31.25	37.71	44.43	51.14	57.86	29.10	32.07	35 03	38.00	44.46	51.18	57.89	64 61	K.
L.	21.71	24.19	26.67	29.15	36.56	42.17	47.77	53.38	28.33	30.81	33.29	35.77	43.18	48.79	54.39	60.00	L.

year, and the interest will also be the same whether the coal used cost $1 or $10 per ton. The saving in the total cost of coal consumed, either during the short hours or at the low price per ton, will not warrant the adoption of high priced steam machinery.

Various other conditions operate to equalize the cost of different kinds of steam machinery. Smaller boilers are required with more economical engines, and the saving in cost of boilers partly compensates for the higher cost of the engines. Coal is now cheap, and economical engines, though lower than formerly, are still relatively high.

Modern steam engines may be divided into high speed and low speed engines. High speed engines are of comparatively short stroke, and develop approximately the same piston speed as long stroke engines by an increased number of revolutions. In most high speed engines the steam is distributed and cut off by a lap valve operated by a governor revolving with the main shaft, which acts to move the center of the eccentric in a line transverse to the crank at a distance from the center of the shaft equal to the lead. The effect is to modify the cut off, as in the link motion, by reducing the throw so that the angular motion required to move the valve through its double lap forms a greater or less proportion of the whole motion, and, therefore, varies the angle of steam admission while the lead is maintained substantially uniform.

In the table the engine on line J is designed for economy in construction rather than the highest economy in fuel. Engine K is a low speed triple compound, and results are the best that can be attained under ordinary average practice, even with the best machinery. Engine L is operated still more economically, by means of boilers of unusual economy and careful firing, etc., $1 per day being added to labor account. Results are maximum with best care available. All engines are assumed to be reliable, and no large allowance has been made for breakdowns. The total loss due to friction of the engine and jack shaft of the slow speed engine is 10 per cent. and for the high speed engines 8 per cent. Column *f* shows the feed water per indicated horse power per hour assumed for comparison. These figures can be depended upon in practice with varying loads affecting the economy. Engines with a uniform load will give lower results, but engines generating electric current for electric railways or subject to variable loads of any kind will rarely show economies as low as column *f*.

Column *g* shows the commercial horse power of the boilers required to furnish steam to engines of the indicated horse power shown in column *c*. The power of a boiler is the quantity of water it will evaporate under normal conditions, and the commercial horse power of a boiler is 30 pounds of water evaporated at 70 pounds pressure at a temperature of 100° F. The price covers the cost of the better class of "safety boilers," in which the water is contained in tubes, small chambers, or comparatively small shells of unusual strength compared to the large shells of ordinary boilers. Tubular boilers are cheaper, and since increased economy is obtained by increased heating surface, ordinary tubular boilers are selected when large ratios of heating surface to grate are desired or boilers of the sectional type employed with economizers at the base of the chimney. Increased surface on tubular boilers chokes the draft. Tubular boilers have not the surplus power of sectional, and when the power varies greatly, as in electric railway work, a greater horse power of boilers of the tubular type must be provided than of the sectional type. Vertical boilers with small tubes are cheap and efficient with steady work, but must be cleaned periodically.

The final result in the table is not due to the price of the boilers selected. Sectional boilers for pressures not exceeding 125 pounds can be purchased and erected in place complete, with necessary attachments, furnaces, brick walls, connections to chimney, steam and blow pipes and other connections, with fire tools and fire room fittings in place ready for regular use for $22 per commercial horse power; and to carry 150 pounds and upward, at $25 per commercial horse power.

The cost in column *h* is approximate. Column *j* is insufficient for elaborate buildings for architectural effect, but could be reduced by using cheap wooden structures.

Columns G N show that for cheap fuel and short hours the engines of fair economy and least cost give the most economical results when both the cost of the fuel and collateral and interest charges are considered, and *the compound engines of comparatively moderate price show better economy, everything considered, than the higher priced triple compound engines*, if results shown in the last line cannot be obtained in average practice. The various devices which are being urged upon the owners of steam plants should not be purchased unless they will save 25 per cent. of their cost annually. The columns of this table foot up two-thirds of this percentage, and as the attention and repairs of miscellaneous apparatus is great, the additional percentage is fully warranted.

The comparison shows the non-condensing engines inferior at every point to condensing engines. Non condensing engines are wasteful of fuel when heavily loaded on account of low expansion, and at light loads the back pressure forms a large proportion of the total resistance, whereas condensing engines will maintain their economy through a wider range on account of the reduction of the back pressure. Back pressure affects the economy of triple compound engines when used non-condensing. Such engines (non-condensing) cannot for irregular loads show any economy over well designed compound engines (non-condensing) unless the steam pressure is carried to 200 pounds or upward, and the size of the cylinders proportioned to the average load.

Under some conditions within the limits of ordinary practice, the prices of economical types of steam machinery compared to price of coal and number of hours' operation, the saving in fuel does not warrant the increase of first cost. This should not be considered a criticism of the practice of others or serve to discourage the higher development of the steam engine, as an investigation of this kind, whatever the result, is calculated to broaden the view by taking into consideration more of the conditions of the problem, and thereby enabling the engineer to secure the best results for each particular case. The table shows for short hours, or low-priced coal, or both, that types of steam machinery to secure the greatest economy of fuel are not warranted, but for longer hours and the higher priced coal the more expensive machinery shows a commercial advantage which increases with the price of fuel. In some cases other conditions must be included for a complete solution of the problem. For instance, in large steamers making long voyages, economical machinery secures, in addition to the saving in the cost of fuel, a saving in the space required to carry the machinery and fuel, and thus increases almost in a geometrical ratio the efficiency of the ships.

The very large expenditures made by some mining companies to save fuel by the use of expensive steam machinery of special design have been fully warranted by the long hours and high price of coal. The enormous mechanical operations of the Calumet and Hecla mines gave the profession unequaled opportunities, which have been grasped in the most creditable manner by our distinguished co laborer in the engineering field, Mr. E. D. Leavitt, who has reared there a series of remarkable monuments of engineering skill, with an expense warranted, doubtless, by the conditions. The development of the great West is, however, now so modifying the conditions that the price of fuel has fallen nearly to the level prevailing at the Atlantic seaboard.

Chlorine Recovery.

[By Mr. C. F. Townsend, F.C.S., in *Engineering*.]

In the fierce competition now existing between our own and other countries for supremacy in chemical industry, the battle will certainly incline to the side which makes the best use of its so-called waste products. Almost every year witnesses the conversion of some substance from an embarrassment and a nuisance into a valuable source of profit. In a similar manner, the great rivals in the alkali trade of this country, the Leblanc and ammonia-soda processes, are racing neck and neck. First one gains a few inches by some economy of fuel or utilization of what was formerly thrown away; then the other, by a desperate effort, makes up its lost ground, and perhaps gains a little on its adversary.

Chlorine recovery is the battlefield around which the contest has raged for the last few years. Far from diminishing, it gets keener and keener, and is absorbing nearly the complete attention of all engaged. The chemical facts and data on the subject have been known for years; the problems to be solved are engineering, and not chemical ones, and every advance made is not due to chemical research, but is in the direction of economy of fuel and improved construction.

The Leblanc, or older of the two processes for the manufacture of soda, consists in first treating salt with sulphuric acid to convert it into sulphate, and then calcining the latter in a revolver with chalk and coal dust. In the first part of the manufacture H Cl is given off in large quantities—

$$2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl.$$

For many years this was allowed to escape into the air, to the detriment of both animal and vegetable life, and the canals around Widnes were nothing but a dilute solution of the acid; so much so that the barges plying on them had to be copper fastened. Its value was at last recognized, and the exit gases from the black ash process were passed through scrubbers to remove it, less than 5 per cent. being allowed to escape at the present time.

Chlorine was first produced from the acid by the well-known reaction with manganese dioxide—

$$MnO_2 + 4HCl = MnCl_2 + 2HO + Cl;$$

and Weldon's process for the recovery of the manganese by mixing it with milk of lime and blowing hot air through it, was one of the earliest steps in the recovery of waste products. New methods, however, are gradually coming forward, and it seems likely that before long the old Weldon process, after many years of valuable service, will be relegated to the background.

Deacon and Hurter's method, which practically burns the hydrogen of the hydrochloric acid, setting free the chlorine, has attained considerable success.

$$2HCl + O = H_2O + Cl_2.$$

The acid, as it comes from the decomposing pots, is mixed with hot air and passed over clay soaked in cupric chloride, raised to 500° C. by waste heat, which exerts a catalytic action, being alternately reduced and oxidized. Unfortunately the contact between the gases and the copper salt has never been sufficient, a good deal of the acid escaping unacted on. As a net result only 30 per cent. is converted into chlorine, the remainder going forward to scrubbers in the usual way to be used in the Weldon process.

The most promising method seems to be the treatment of hydrochloric acid with nitric acid, for which purpose plants have been erected recently, both in England and Scotland. As in all other systems, the principle has been known for a very long time, the first patent having been registered in 1838, and the difficulties to be overcome have been mechanical ones. In 1847 Dunlop made a great effort to work the process, but was not rewarded by commercial success. It is again attracting attention, and is to be worked in Scotland under Mr. W. Donald's patent, whilst a modification devised by Messrs. G. E. and H. R. Davis will be tried in Cheshire. The elimination of chlorine by means of nitric acid is, of course, only another way of burning the hydrogen of the hydrochloric acid, the nitrous acid acting as carrier, and the recovered oxides of nitrogen being used over again. The advantage of this system, if it can be worked successfully, will be that the whole of the chlorine will be acted on, instead of only half, as in the Weldon, and a third in Deacon and Hurter's process.

$$2HCl + 2HNO_3 = N_2O_4 + 2Cl + 2H_2O.$$

The Solvay or ammonia-soda process works on entirely different lines to the Leblanc. Brine is used in place of dry salt and ammonia, and carbonic acid gas is passed through the hot solution. The following reaction takes place:

$$NH_4HCO_3 + NaCl = NaHCO_3 + NH_4Cl.$$

The bicarbonate crystallizes out, and is either sold as such or converted by heat into the normal carbonate; whilst the ammonium chloride is heated with lime, calcium chloride being formed as a waste product, and ammonia passed back into the plant to be used over again. The soda obtained is very pure and clean, having the advantage in this respect over Leblanc soda, which is freed from its impurities, consisting of sulphide and chloride of sodium, with some difficulty. The ammonia-soda process had an uphill fight for many years. The great trouble besetting its promotors was unsound joints, through which ammonia continually escaped. After immense perseverance these mechanical difficulties were got over, and it is now gaining steadily on its rival, as the following figures, taken from the Alkali Inspector's report for 1892, will show:

	1891.	1890.	1889.
Soda made by Leblanc process..	567,863	602,769	584,203
Soda made by ammonia-soda....	278,528	252,260	219,279

Every inch of the ground, however, is fiercely contested, and the old method has still a good many years of life before it, as far as one can see at present. But if the ammonia-soda makers could recover the chlorine, which they now lose as calcium chloride, in a cheap and satisfactory way, they would probably drive their adversaries off the field.

As may be imagined, invention after invention has been contrived towards this end, but up to now with very limited success. The similar problem at Stassfurt, where 200,000 tons of magnesium chloride, containing three-fourths of its weight of chlorine, are thrown away annually, also acts as a spur to inventors. In 1887 Prof. Dewar brought the Weldon-Pechiney process to the notice of the Society of Chemical Industry. It was based on the fact, discovered by Graham and Davy, that chloride of magnesium can be decomposed by hot air into magnesia and free chlorine. The late Mr. Weldon had attacked the chemical side of the question, and M. Pechiney the engineering difficulties, and between them they had elaborated a very beautiful piece of chemical engineering. The difficulties to be overcome were very great on both sides. Temperature as high as 800° C. to 1,000° C. had to be used to decompose the oxychloride, and the vessels used had to be lined with fireclay on account of the action of hydrochloric acid on iron. The process consisted of five stages:

1. Dissolving MgO in HCl.
2. Preparation of the oxychloride.
3. Crushing, breaking and sifting the oxychloride.
4. Drying the compound.
5. Decomposing it.

Magnesium chloride solution cannot be evaporated to complete dryness, as after $MgCl_2 + 6OH_2$ is formed, decomposition into oxychloride and hydrochloric acid begins to set in. Great care had to be exercised in this operation, and the final composition of the oxychloride was:

	Per Cent.
Impurities	5.47
Water	21.62
$MgCl_2$	44.45
MgO	28.36

About 40 per cent. of the chlorine was obtained as such, and the same quantity as HCl, whilst the rest was left still combined with the magnesia. When the oxide was formed it had a tendency to break down into fine dust, which gave a good deal of trouble. The final apparatus was erected in France, and was pronounced by every one who had seen it to be a marvel of engineering skill. The plant was, however, excessively complicated, very costly, and the fuel consumption very high; and, besides this, the wear and tear at such a high temperature was very considerable. It seems probable that the combined difficulties proved too great to admit of commercial success, for we have heard very little as to its working lately.

Very recently a special article in the *Times* announced that Mr. Ludwig Mond, of Brunner, Mond & Co., who work the ammonia soda process, had succeeded in overcoming all difficulties, and that chlorine recovery in the Solvay process was a *fait accompli*. The method is so similar to that just described that one cannot be blamed for feeling somewhat sceptical on that subject. As far as one can learn from published accounts, if anything should succeed in solving the problem, which was entirely an engineering one, the beautiful apparatus of M. Pechiney should have done so. The same difficulties of construction, the same high temperatures, and large fuel consumption still remain, and it is difficult to believe that they have been overcome, in spite of Mr. Mond's perseverance and vast experience.

Instead of treating the ammonium chloride, obtained in the ammonia soda process, with lime to recover the ammonia, it is stated that in the new method the ammonium salt is crystallized out, and then volatilized at 350° C. in a vessel containing melted zinc chloride. The vessel is of iron, lined with antimony or an antimony alloy to protect the iron from the action of vaporized HCl, and the bath of zinc chloride is necessary to prevent the temperature from rising to the fusing point of antimony (452° C.), and also to render the evolution of the gases more regular. The mixed gases from the decomposition of ammonium chloride are led into a second vessel containing magnesia. The hydrochloric acid is taken up by the magnesia to form hydrated chloride, and the ammonia passes on to be returned to the soda plant as formerly. When the tension reaches a certain point, the action stops, the gases are cut off, and the hydrated chloride is decomposed by air at 1,000° C., as in the Weldon-Pechiney process. The chlorine is driven off to be used in the production of bleaching powder, and the magnesia is left behind as at the commencement, ready to repeat the operation. The magnesia vessel, instead of pure magnesia, contains balls of a mixture of magnesia 100 parts, china clay 75 parts, and lime 6 parts, made into a paste with potassium chloride. The object of this is to give a large surface for the reaction, and to counteract the tendency of the oxide to degenerate into dust. The reaction, as a whole, may be represented thus:

1. $2NH_4Cl + MgO = MgCl_2, OH_2 + NH_3.$
2. $MgCl_2, OH_2 + O = MgO + OH_2 + Cl_2.$

All the water is driven off at 550° C., but a considerable amount of HCl is formed at the same time. In the Weldon-Pechiney process half the chlorine recovered was in the form of HCl.

It will be seen that the difference between the two methods is very small, with the exception of the ammonia portion, which is preliminary. When we come to examine the matter thermochemically, we see that the ammonia is a very serious part. The ammonium chloride solution only contains some 20 per cent. of the salt, so that for every molecule of NH_4Cl obtained, four times its weight of water have to be evaporated. The salt must then be volatilized and decomposed at 350° C., requiring heat as follows:

	Cal.
Evaporation of 53.5 × 4 kilos water (53.5 × 4 × 537)	114,918
Decomposing 53.5 kilos NH_4Cl	41,900
Raising 17 kilos NH_3 from 100° to 350° (17 × .5084 × 250)	2,160
Raising 36.5 kilos HCl from 100° to 350° (36.5 × .194 × 250)	1,770
Heat of solidification of NH_4Cl	+3,880
	—160,748
	+ 3,880
Net requirement	156,868

Supposing, for the sake of comparison, that all the chlorine in the new process is obtained in a free state—a very favorable supposition—we should have the following yield at the completion of the reaction :

MgO	40.0
Cl	71.0
H_2O	18.0
	129.0

and for the oxidation 16 kilogrammes of oxygen or 80 kilogrammes of air would have to be blown in at 1,000° C. The heat required is therefore—

	Cal.
80 kilos. air to 1,000° C. (80 × .2375 × 1,000)	19,000
40 kilos. MgO 350° to 1,000° (40 × .244 × 650)	6,344
For inert materials mixed with MgO, say	5,000
35.5 × 2 kilos. Cl from 350° to 1,000° (71 × .12 × 650)	5,538
18 kilos. steam from 350° to 1,000° (18 × .48 × 650).	5,600
	41,482

As it is a continuous process, the chemical work comes in twice in opposite directions, and may be neglected. This figure, 41,482 units, is for 2 Cl, so that for one equivalent we shall have half this, 20,741 calories. To this must be added 156,868 from the preliminary operation, giving a total of 177,609 calories which represents the minimum quantity of heat necessary for the operation, without any allowance for loss by radiation, etc. In face of these exceedingly high results, it is difficult to see how success can be hoped for, whatever economies of fuel are practiced.

When we compare it with other chlorine processes, such as the Deacon, where the thermochemical equation is on the plus side :

$$\begin{aligned} 2\,H + 2\,Cl &= 44{,}000 \\ 2\,H + O &= +58{,}700 \\ &\overline{\qquad\qquad} \\ &+14{,}700 \end{aligned}$$

and in which the highest temperature reached is 300° to 400° C., or the method of oxidation by nitric acid :

$$2\,HCl + 2\,HNO_3 = 2\,Cl + N_2O_4 + 2\,H_2O.$$

$$\begin{aligned} 2\,H + 2\,Cl &= 44{,}000 \\ N_2O_4 + O + Aq &= 9{,}335 \\ 2\,H + O &= +58{,}700 \\ &\overline{\qquad\qquad} \\ &+5{,}365 \end{aligned}$$

it is even more difficult to believe that a system working on these lines can be a commercial success under present conditions, although we must not forget that the chlorine of the ammonium chloride is a waste product and costs nothing. The heat consumed in the black ash portion of the Leblanc process, as given by Dr. Hurter, is only 98,000 units, and if we add 15,800 calories for the preliminary conversion of the salt into sulphate, 113,800 for the whole manufacture ; the subsequent eliminary of the chlorine from the hydrochloric acid, whether by the Weldon or other oxidizing process, not requiring additional heat theoretically.

The most serious items in the suggested process are the evaporation of the water and the heating of the air required to decompose the magnesium chloride. Waste heat from other sources may minimize the cost of the former, but there is no means of applying it to the latter purpose, whatever quantity may be available. The chemical work is comparatively trifling, but it is the difficulty of dealing with the large masses of inert material and useless volume of nitrogen at such a high temperature, which raises an apparently insuperable obstacle in the inventor's path.

In addition to purely thermochemical processes, many attempts have been made to apply electricity, not only to the formation of chlorine and bleaching compounds generally, but also to the production of caustic soda and chlorine by direct electrolysis of salt itself ; the most notable among them being the Hermite process. The stumbling block has always been the difficulty of finding a diaphragm capable of separating the irons without adding largely to the resistance. Messrs. Cross and Bevan, however, have described a very ingenious diaphragm in connection with the Le Sueur process, which is said to work perfectly. Electrolytic methods are certainly coming into use for the manufacture of bleaching powder and the weak alkali used in paper mills. Whether they will succeed in competing with the older processes for producing pure materials is another question altogether. It is claimed that with power costing only two-thirds of a cent per 1,000 watts, or ½ cent per horse power hour, the task can be accomplished successfully, but the difficulties are not yet overcome, and it may be some time before the goal is reached.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

On the 1st of May Mr. Newberry Updyke will take charge as Superintendent of the works of the Bristol (Pa.) Gas Light Company, replacing Mr. George W. Booth, resigned.

Work has been commenced on the new 500,000 cubic foot holder for the New Haven (Conn.) Gas Light Company This will be the fourth holder owned by the Company, and when completed will enable it to store something over one million cubic feet.

Mr. Charles F. Prichard, General Superintendent of the Lynn (Mass.) Gas and Electric Company, has convinced his Directors that it would be good politics to order a cut in the rates for gas ; for the Company has notified its consumers that on and after July 1st next the supply will be maintained on a schedule calling for $1.30 per 1,000 cubic feet. This is an extremely liberal rate, but it ought to have a rather depressing effect on the output of incandescent electric lighting current furnished by the "other" division of the Company's works.

The Atlantic Improvement Company, of Long Island City, N. Y., has placed the contract for its new power station, consisting of an engine and boiler house and dynamo room, with the Berlin Iron Bridge Company, of East Berlin, Conn.

"J. M. W.," writing to us from St. Louis, Mo., under date of April 14th, among other things, says : "You will probably recognize my name in connection with the management of the Washington (Ind.) Gas Company, where we have had quite an experience with electricity. Until recently the Gas Company operated at Washington a small arc plant successfully, by gas engine power. At expiration of contracts competitors for electric lighting entered the field, offering to do business for *nothing*, as we thought, whereupon the Gas Company withdrew and our competitors 'got it.' Since the contracts were awarded competitors have established in Washington arc and incandescent plants in competition with gas. The Gas Company refusing to reduce the price of gas, many consumers of gas accepted the offer of the electric light company to wire their houses for nothing, and supply them with electric lighting as cheaply as the Gas Company would supply gas light. For several months such consumers only consumed gas when they could not get electricity ; and on March 1, 1893, seeing that the Gas Company in such cases was simply operating its works as a tender in support of an uncertain and irregular electric light plant, I removed the meters of such consumers of electricity to the exclusion of gas. As Gas Company's business was to make and sell gas, I declined to rent meters, and so competition goes on. The Gas Company will continue to do business on business principles, and is satisfied with the correctness of its position. There is ample room for both."

We take the liberty of printing the following extracts from a letter recently received by us from a Boston correspondent : "The report in your Journal of April 10th, of the paper upon the question of whether a small gas company should go into electric lighting, and the discussion of the paper by the members of the Ohio Association, is so strong a confirmation of my own belief that a small gas company had better stick to gas making, that I cannot help being gratified by the evidence that I have not been far wrong in keeping my companies out of the electric business. Two of the companies with which I am connected have, to be sure, charters from the State Legislature authorizing them to supply electricity (they were in fact the first companies in the State, if not in New England, to procure such charters), which were secured by me personally ; but the more I have investigated the subject, and the longer I have watched results of ventures in that direction, made by others in the gas business, the better satisfied I am with my own course in the matter. The towns of Danvers and Marblehead have both appointed committees to investigate and report upon the cost of a municipal electric plant—in the case of Danvers, for commercial lighting, as that town has already a street lighting plant ; in the other case, for

both street and commercial lighting. In each town there are among the taxpayers (who will have to pay the bills) conservative citizens who believe that such a hazardous business—I mean not only hazardous to life and property, but hazardous also from a financial point of view—should be left to private corporations. Such testimony as is given in your report would be very valuable to those citizens and others opposed to municipal ownership in general, and if published in the form of a little pamphlet would form an excellent 'tract' for general distribution. Of course, it would need a little revision, and the cutting out of such portions as would not be understood by the general reader; but if it were published I am quite sure it would prove invaluable to the gas companies and to the taxpayers in small towns referred to. Meantime I wish you would send me * * * of the JOURNAL, and I will see that the article referred to is put where it will do the most good, first culling out the most valuable portions. * * * * * *. F."

THE Hartford (Conn.) *Courant* says: "The Hartford City Gas Light Company has bought the property 236 Main street, long the residence of the late Ezra Clark, father of President Clark, of the Water Board. The property fronts 34 feet on Main street, and, running back 200 feet, has 27 feet frontage on Grove street. The Gas Company will tear down the old house and put up an office building on Main street, and will also build on the Grove street front a salesroom and repair shop, so that the change involves radical improvements that will make that whole locality look better. Since the Gas Company moved its office uptown some years ago and came in direct contact with the people who were passing to and fro, its business in the sale of gas consuming apparatus has very much increased. The new move, carried out with the good taste that marks the works of its managers, will make its headquarters still more attractive."

THE general dimensions of the new buildings for what is to be known as the Menominee division of the plant of the Milwaukee Gas Light Company, are 90 feet by 120 feet by 50 feet, at the highest point. Mr. James Graham will construct the buildings, from plans furnished by Messrs. Bartlett, Hayward & Co., of Baltimore. The plant will be located on Milwaukee street, between Menominee street and Corcoran avenue.

THE State Board of Gas and Electric Light Commissioners have handed down a batch of decisions, in respect of the cases before them, in which petitioners asked for a decree reducing the selling rates in their respective districts. In Boston proper the rate is cut to $1 per 1,000 cubic feet; in Springfield it is put at $1.40 per 1,000—a reduction of 35 cents; in East Boston it is fixed at $1.50 per 1,000—a lessening of 25 cents.

THE proprietors of the Citizens Gas and the Willimantic Electric Light Companies, of Willimantic, Conn., have leased a spacious store in the Hayden Block, where hereafter will be located their general offices, show rooms, salesroom, etc.

THE Claremont (N. H.) Gas Company is dickering with the exploiters of the celebrated Sanitary gas process. A local authority, in commenting on the negotiations, affirms that the Sanitary "gas is different from that formerly made," which affirmation goes without saying. In fact, it is fearfully and wonderfully made.

MR. N. L. JONES, formerly "consumption clerk" at the Spring Garden gas station, Philadelphia, Pa., has been appointed Delinquent Tax Collector.

THE following explains itself—the reduction is equivalent to a concession of 20 cents per 1,000 cubic feet: "We, the Presidents of the existing Gas Light Companies of Buffalo, N.Y., at a conference held this day (April 10) adopted the following preamble and resolution, and desire through you [the Board of Aldermen and Common Council] to communicate the same to the citizens of Buffalo:

Whereas, We have from long experience come to the conclusion that the introduction of new gas companies, the consequent increase of capital calling for dividends, the tearing up of streets, the duplication of gas mains and plants and the increased expenditures attending the operation and management of these plants, have hitherto served only to retard the reduction in prices of gas to public and private consumers and have in no wise tended to improve the quality of gas; and

Whereas, It is our desire as citizens having important local interests and investments at stake to protect them against attack and at the same time subserve the public interests and do all that we can to aid in the development of our city. Now, therefore, it is

Resolved, That the price of gas to private consumers in our respective districts be reduced, from July 1st, 1893, to $1 per 1,000 cubic feet; that bills, as hitherto, be rendered monthly to consumers at $1.20 per 1,000 cubic feet, and that upon these bills a discount of 20 cents per 1,000 cubic feet be allowed, if bills be paid at our respective offices, on or before the tenth day of the month. We desire to say to you further that a reduction on our part had been in contemplation before we ever heard of the Queen City Gas Company, and probably the same result would have been reached at a comparatively early day, but we make it public now because we believe that it will satisfy a public sentiment, which, so far as possible consistent with a fair return upon our investments, we have always desired to meet.

THE above manifesto, which bears the signatures of the respective Presidents of the three Buffalo Gas Companies, will not be pleasantly received by the projectors of the Queen City Gas Company, whose dickerings with the Legislature and with the authorities of Buffalo, in the matter of obtaining a free lance gas charter for Erie county and certain other "adjoining parts" of the State, have been little short of scandalous. The State official, whom the "boys" delight to call "Blue-eyed Billy Sheehan," might far better be engaged in other pursuits than that of prostituting his power and opportunity; but as all's well that ends well, it is matter for congratulation that the bold stand taken by the dominant gas interests of Buffalo will quite effectually puncture "Blue eyed Billy's" proposed grab. He could not interest capital sufficient to engage another Company in business at Buffalo to day—or tomorrow, for that matter—while the gas rate stands at $1 per 1,000; so if "Billy" wants to get even a bow-wowing chance at Buffalo's gas supply he must endeavor to purchase control from the people who have been and are now in the field. The trouble is, however, that the present owners know full well the value of what they have got, hence "Billy" will not likely be able to repeat the coup that was so successfully brought off a few years ago in Albany and Troy by "Ed."—otherwise Senator—Murphy, "Tony" Brady and their fellow bluffers.

ACCORDING to the Philadelphia *Record* of the 17th inst., the startling fact appears from the annual report of Director Windrim that the city lost more gas last year by leakage than it burned in all its 20,000 street lamps, which wasted gas was worth over $800,000. The amount thus lost was 561,650,395 cubic feet, or 13.66 per cent. of the entire output, and nearly 100,000,000 cubic feet more than the leakage of 1891. The gas consumed in the street lamps in the same time was 501,160,281 cubic feet, or 12.21 per cent. of the total product. Although this appears to be an immense money loss to the city, it is, as a matter of fact, comparatively small when the extent of the city's plant and all the various conditions are taken into consideration. An official of the Gas Bureau stated yesterday that the leakage in this city was less than that in any other large city, and even here very much smaller than it was some years ago, when the leakage ran as high as 22 to 28 per cent. of the amount manufactured. "Philadelphia has over 1,100 miles of gas mains," he said, "more than any other city in the world, and to force the gas through miles of pipe of all kinds and conditions will cause a considerable loss in itself. The heaviest loss, however, comes through breaks in the mains, which are constantly occurring, especially in cold weather. The winter just past has been the worst in that respect for many years. During the cold weather in January and February there were in all 173 breaks, and Chief Park had continually 150 men on the streets, day and night. With the rapid increase in the number of conduits it is getting more and more difficult to locate the breaks, the gas being sometimes carried half a mile or more in different directions before it reaches the surface, requiring several days before the most expert men can discover the break. The small and old pipes are also a constant menace, as in our system of 'pulling' the gas to the distant sections of the city by means of exhaust pipes. In view of all these facts the loss is really small. There is no means of estimating the leakage except by deducting the total amount accounted for from the total manufactured. Loss through a defective meter, etc., would all come under this head."

THIS reported percentage of leakage at Philadelphia is abnormally high, although no doubt very much of the excess is chargeable to the wretchedly inadequate system of mains with which the city is burdened. In New York City the leakage does not exceed 10 per cent., which is also considered excessive, but which is fairly explainable on account of or chargeable to the street improvements underway in the city and to the upheavals that accompanied the putting down of the Broadway and Third avenue cable railroad systems. However, the "official of the Gas Bureau" who was interviewed by the *Record* man

is sadly at fault when he asserts that "Philadelphia has over 1,100 miles of gas mains—more than any other city in the world." Our impression is that the mileage of mains operated by the New York Gas Companies is well in excess of 1,100 miles, but in default at the moment of the exact figures,* we will not positively so state. There can be no mistake, however, about London, for instance. There "Field's Analyses" for 1891 shows the Gas Light and Coke Company has 1,883 miles of mains, the Commercial Company 264 miles, and the South Metropolitan 783 miles—a total of 2,929 miles; and that London is very much in the world's evidence, nobody can deny.

THE proprietors of the Asbury Park (N. J.) Gas Light Company have ordered that the fuel gas rate be reduced to $1.40 per 1,000 cubic feet.

THE Morristown (N. J.) Company's distributing system will be largely added to this season. Work has been commenced on the same in Spring street and Speedwell avenue, through which a 6 inch main will be carried to the northern corporate limit of the city.

SOME gas companies seem to have poor luck in the nature of the services rendered by their employees, and the following is a sample of the "luck" enjoyed by the Boston Company on a recent occasion, our report of which is taken from the Boston *Advertiser:* "While workmen were employed in putting in a gas meter in the dwelling of G. R. Flint, on Humboldt avenue near Waumbeck street, at 5:30 P.M., on April 14, the gas was turned on, and one of them held a *lamp up to the meter.* There was a terrific explosion and the kitchen above was wrecked and both of the men in the cellar were thrown down, but escaped comparatively uninjured."

WHAT was known as the Allen & Sweeney Electric Light and Railway Company, of Dubuque, Iowa, was recently sold at foreclosure. The purchaser was the Old Colony Trust Company, of Boston, Mass.

THE Elkton (Md.) Gas Light Company will construct a new retort house, and the contract for the retort and fire brick construction in same has been awarded to Mr. Cyrus Borgner, of Philadelphia.

THE City Gas Works, Alexandria, Va., will add two new benches of sixes to the carbonizing plant—an addition that should have been made a year ago.

THE Bethlehem (Pa.) Gas Company is constructing a two lift telescopic gasholder, to rest in a steel tank. It is rated to store 200,000 cubic feet. The builders are the National Iron Works, of Lynwood, Pa.

THE Sioux City (Iowa) Gas Company has decided to place a 12-inch feeding main through Nebraska street, from Fourth to Twenty-ninth street. This will be worth many thousands of dollars to the Company, taking into account the saving to itself and the far greater satisfaction to its patrons that cannot fail to result.

MR CHARLES D. LAMSON, President of the Worcester (Mass.) Gas Light Company, has served the following notice to the gas consumers of that city, which is directly aimed at a local concern styling itself the "Worcester Gas Meter Company":

"To the consumers of the Worcester Gas Light Company—Your gas meter is the property of this Company. We hereby notify you that you must not allow any person to disturb said meter or its connections, without our consent. All employees of the Company carry certificates signed by the President of the Company. They will show them whenever requested to do so. Any person without such a certificate has no right to interfere with our meter in any way." In explaining the Company's position in respect to this matter, Mr. Lamson said: "We have no objection to the Meter Company introducing its governors, but we do object to any interference with our pipes and connections. In one or two instances we have discovered leakages caused by tampering with our connections. Of course, in such a case the Gas Company is held responsible. That is the whole reason for the issuing of the notice. We don't object to the governors, but they must not tamper with our connections."

SUPERINTENDENT T. D. PETCH has good reason to be proud of the compact and well-arranged gas plant which he directs at Eureka, Cal. The works are of ample capacity, and it is to be put down to his credit that the loss from leakage does not exceed 7 per cent.

THE annual meeting of the Spokane Falls (Wash.) Gas Light Company will be held on the morning of May 9th.

* Since this was written, search through the records reveals the fact that the total number of miles of mains operated by the New York City Companies (6) in 1891, was 1,306¼.

MR. J. G. EASTLAND, President of the Stockton (Cal.) Gas Light and Heat Company, after a thorough inspection of the conditions, has virtually decided to put down about four miles of main pipe in that city this season.

A GAS consumer at Jamaica, Long Island, recently informed the local Gas Company that he was sure his meter was not registering the full quantity of gas used by him at his home. Not only did he say that, but followed up his remarks by tendering the Company a $5 bill, to be credited to him in addition to the face of the account for gas consumed in March rendered by the Company. To think, too, that that man is a Long Islander!

WORK on the gas plant at Crookston, Minn., is underway.

PROPOSED GAS ASSOCIATION FOR THE PACIFIC COAST.—In our issue for March 27th (p. 443) the intimation was given that there was every likelihood that before long another Association would come to life, this time on the Pacific Coast. As a sequel thereto we publish the following circular, recently mailed to the Gas Companies of California, Nevada, Utah, Arizona, Washington, Montana, Wyoming, New Mexico, Oregon and British Columbia—70 in all. The only comment we have to make thereon now is to express the hope that the plan will receive the hearty assent that its importance deserves.

OFFICE OF THE SAN FRANCISCO GAS LIGHT COMPANY,
SAN FRANCISCO, April 13th, 1893.

Gentlemen: It is the expressed desire of many of the officers of the various Gas Companies on the Pacific Slope to unite in forming a Pacific Coast Gas Association. The field is large and covers a list of about 70 Gas Companies. If an interest is taken, and a fair representation of these Companies is obtained, it is believed that a large and successful Association can be formed.

In the portion of the United States east of the Mississippi river there are 7 flourishing Associations of this kind, while west of the Mississippi there are no regular gas guilds or Associations, and even the Western Gas Association seldom holds a meeting so far west as the Mississippi, and there has never been a meeting of gas engineers west of the Rocky Mountains.

This territory embraces rapidly growing cities and towns full of enterprise, and covers a large gas consuming district. The object of the new Association will be the promotion and advancement of knowledge of the gas business, including all matters relating to the construction and management of gas works, and the manufacture, distribution and consumption of gas. To establish a spirit of fraternity between the members by social intercourse and friendly exchange of information on the subject of gas.

It is proposed to hold the first meeting for the purpose of organization, etc., in the city of San Francisco, Cal., about the last of June, or first of July, and, besides the regular business of organizing, it is hoped that some interesting papers will be read, and it has also been suggested that the Question Box be made a feature of the meeting, and that questions be sent to us well in advance, to be embodied in a circular which will be sent out with the regular notifications of the meeting. This will afford an opportunity to collect memoranda and insure intelligent and satisfactory answers to all questions presented. An opportunity will be afforded to inspect the new works of the San Francisco Gas Light Company, as well as the other gas plants in the city.

It has been proposed that the Association shall consist of Active, Associate and Honorary members. Active membership to include all officers of gas companies and persons engaged in the supervision of gas manufacture. This would include Presidents, Managers, Treasurers, Secretaries, Engineers, Superintendents and Assistant Superintendents. Associate members would include persons whose pursuits constitute branches of gas engineering.

A meeting could be held each year at such time and place as may be decided upon. We earnestly wish (and we are joined in our desire by many of the gas engineers on the Coast) to see a successful and flourishing Association formed, and we urge you to place this letter in the hands of the officers of your Company as an invitation to them to become members of it. In order to prepare the notifications, solicit papers and inaugurate a "Question Box," it will be necessary that each one who desires to assist in forming this new Association, and will become a member of it, shall notify the undersigned at the earliest possible moment. We enclose a list of Gas Companies to which copies of this letter have been sent, and if any have been overlooked will you kindly correct and return it?

The preliminary work attending the formation of an Association of this kind is arduous, but will be lightened and made pleasant if you write fully your ideas, and any suggestions that may occur to you bearing on the welfare of the new Association.

Trusting to receive favorable replies from all the officers of your Company, we are very truly yours,

J. B. CROCKETT, President and Engineer.
E. C. JONES, Assistant Engineer.

The Market for Gas Securities.

A disturbed money market kept all classes of shares see-sawing during the week, but the adjournment of the Legislature ought to act as a counter-irritant in the matter of quotations for city gas shares. Consolidated opened to-day (Friday) at 126 bid, and the indications were for higher figures. Equitable sold off slightly during the week, transfers in it having been made at 192, although 198 is offered for it to-day. Mutual is steady.

Brooklyn shares, save Williamsburgh and Nassau, are weaker. The negotiations for consolidation are going along somewhat unevenly, but it is measurably certain that progress is being made. Chicago gas was forced down to 84½ on Thursday, and the opening bid to-day was 84¼. Bay State is weaker, at 26 bid, and Baltimore Consolidated is strong at 63⅞ to 64.

Stockholders' Meeting.

OFFICE OF THE UNITED GAS IMPROVEMENT COMPANY,
DREXEL BUILDING, PHILA., PA., April 20, 1893.

The annual meeting of the Stockholders of the United Gas Improvement Company will be held at the Company's Office, Drexel Building, Phila., on Monday, May 1st, at 12 o'clock noon, when an election will be held for a President and six Directors to serve for the ensuing year, and such other business transacted as may be brought before the meeting.

The stock transfer books will be closed from 3 P.M., Tuesday, April 25, until 10 A.M., Tuesday, May 2.

EDWARD C. LEE,
933-1 Treasurer.

WANTED,

Competent Erector for Coal and Water Gas Apparatus; also,

One Experienced Water Gas Operator.

State experience. THE WESTERN GAS CONSTRUCTION CO.,
933-2 Fort Wayne, Ind.

Position Wanted

AS SUPERINTENDENT, ENGINEER, OR ASST. ENGINEER OF GAS WORKS,

by a good, reliable man, who is a first-class draughtsman, familiar with the construction of all kinds of Coal and Water Gas Apparatus. Best of references. Address "A. B. C,"
933-4 Care this Office.

WANTED,

A Set of Second-Hand Purifiers,

6 x 6 feet, in good order. Address, with full particulars as to condition and price,

"W.," P. O. Box 3582,
933-2 Boston, Mass.

A GOOD, SAFE INVESTMENT.

FOR SALE—Consolidated Gas and Electric Light Plants,

doing a good business in the best town in Southwest Missouri. For further particulars address Lock Box 593,
933-8 Fort Scott, Kansas.

FOR SALE,

Complete Electric Light Plant,

Consisting of—

One 25-horse power Otto Gas Engine, Belts, Shafting, etc; one 35-light Arc Dynamo, Waterhouse System, with Reserve Armature; 32 Arc Lamps, 1,700 candle power; 4 miles of Insulated Wire Circuit; Poles, Cross-arms and other Appliances. Condition first-class. Will sell for cash or well-secured paper.

Apply to JNO. M. WOODSON,
933-2 511 Olive Street, St. Louis, Mo.

WANTED,

A Mechanical Draughtsman.

One familiar with gas settings and general firebrick work preferred. Address, stating age, experience and references,

"S. L. K.," Brooklyn *Eagle* Office,
932-2 Brooklyn, N. Y.

Position Wanted

AS SUPERINTENDENT OF A GAS WORKS,

by a man thoroughly posted in all branches of the business, including construction work. For several years past has had full charge of a plant sending out over 10,000,000 a year. Wishes now to secure a larger works, or one where there is more chance for growth. References given. Address
932-2 "W.," care this Journal.

Position Wanted

As Superintendent of Gas Works,

by a man fully competent in every respect, and who has had 20 years' experience. Or **would Lease a Small Works.**
930-tf Address "J.," care this Journal.

Position Wanted

As Superintendent

by a man having 18 years' experience. Has a thorough knowledge of the business, in all its branches and details. Address
930-4 "M. L. H.," care this Journal.

FOR SALE,

Two Ten-Inch Dry Center Seals,

in good condition, and one

Small Multitubular Condenser,

4 ft. diameter and 14 ft. high.

For particulars inquire of FRED. BREDEL, C.E.,
929-tf 118 Farwell Ave., Milwaukee, Wis.

FOR SALE,

Two Westinghouse Engines, of 12 H.P. each.

Ten 12-inch Chapman Valves.

All in good order. Address NEW HAVEN GAS LT. CO.,
922-tf New Haven, Conn.

THE GAS WORKS CONSTRUCTION CO.

ENGINEERS AND CONTRACTORS

FOR THE

Erection of New or the Rebuilding of Old Works.

LAYING of CAST or WROUGHT IRON STREET MAINS.

Special Attention Paid to the Building of Holder Tanks.

Plans, Specifications and Estimates Furnished on Application

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It is well known that a large majority of all High Power Gas Lamps in the United States have my Governors attached, and they are always used by the leading makers of these lamps. To remove any excuse for the use by anyone of inferior and infringing Governors, a reduction in price has been made, and all exclusive contracts are cancelled.

Correspondence Solicited with all who require a Reliable Governor.

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OFFICE AND WORKS,
938 to 954 River Street and 67 to 83 Vail Av.,
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Hydraulic Main Regulators, Check Valves, Foot Valves, Yard-wash and Fire Hydrants. Send for Circulars.

Valves.—Double and Single Gate, ¼ in. to 48 in., outside and inside Screws. Indicator, etc., for Gas, Water, Steam, and Oil. Send for Circulars.

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Valves and Gates for Gas, Ammonia, Water, Etc.

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